DOCUMENT RESUME

ED 221 356 SE 039 102

TITLE Proceedings of the Symposium on the Effects on Technology of a Vanishing Species: Mathematics and Science Teachers.
INSTITUTION State Univ. of New York, Albany. School of Education.
PUB DATE 21 May 82
NOTE 39p.
AVAILABLE FROM The Institute for School Development, State University of New York at Albany, 135 Western Avenue, Husted 211, Albany, NY, 12222 ($3.50).

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Cooperative Programs; Elementary School Mathematics; Elementary School Science; Elementary Secondary Education; Higher Education; Industry; *Mathematics Education; *Mathematics Teachers; *School Business Relationship; *Science Education; *Science Teachers; Secondary School Mathematics; Secondary School Science; Teacher Education; Teacher Recruitment; *Teacher Shortage
IDENTIFIERS New York

ABSTRACT

The symposium whose proceedings are included in this document was designed to inform diverse segments of society of the catastrophic decline in the supply of mathematics and science teachers. It was also seen as a first step in a continuing dialogue among educators, legislators, and corporate executives in New York State. The symposium was, thus, structured as a "lighthouse" endeavor focusing on sensitizing the non-education community, in particular, high-technology industry, to a situation which will have enormous, deleterious effects on their ability to expand, to modernize, and to reap the rewards of technological advancement. Issues/topics discussed include: (1) myths about the mathematics/science teacher shortage (pay teachers more and shortage will disappear, retraining is the answer, talented people will be unaffected by inadequate/inappropriate instruction in foundation courses of science and mathematics); (2) data on the extent of the shortage; and (3) Regent's initiatives, including a proposal of a joint business/industry/education effort to enable capable high school students to enroll in collegiate programs preparing them for teaching in elementary/secondary schools for 3 years and then to enter positions in business and industry. Twenty recommendations from three working groups are also reported. (Author/JN)

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PROCEEDINGS OF THE SYMPOSIUM ON THE EFFECTS ON TECHNOLOGY OF A VANISHING SPECIES: MATHEMATICS AND SCIENCE TEACHERS

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Proceedings of the

Symposium

on

The Effects on Technology of a Vanishing Species: Mathematics and Science Teachers

State University of New York at Albany

May 21, 1982

Sponsored by

Department of Teacher Education

State University of New York at Albany

In cooperation with:

Association of Mathematics Teachers
of New York State

Science Teachers Association
of New York State

and

Bureaus of Mathematics Education and
Science Education
of
The New York State Education Department

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PREFACE

This publication is the first of a series of monographs and reports to be produced under the aegis of the Institute for School Development. They are designed to present the results of research of the faculty of the School of Education, the deliberations of scholars at invited conferences, as well as position papers on issues of concern in the field of education. Collectively the series will provide a view of not only the scholarly interests and activities of faculty, but a statement of the continuing commitment of the School of Education to the enhancement of the quality of life through education.

We hope you find these publications informative and stimulating. We invite and welcome your comments and observations.

FOREWORD

Among the subjects taught in high school, the teaching of science and mathematics are in the most serious state of disrepair. Thirty-four percent of high school sophomores are taking remedial courses in these fields. Twenty-five percent of the mathematics courses in public colleges and universities are remedial. Almost twenty-five percent of the reported teaching vacancies in science and mathematics for the 1980-81 school year were filled by teachers from other fields of preparation.

Our nation's educational system is a reflection of our society in all its complexity. Our society is now producing fewer competent science and mathematics teachers. Noncompetitive salaries and generally unfavorable working conditions are to a significant extent to blame. Additional blame can be placed on the fact that many states, in the late 1960's, eliminated standards for graduation from high school. Florida and California, for example, eliminated all state requirements for graduation from secondary school. Associated with the reduction in state requirements for graduation was the lowering of standards for admission by colleges and universities.

The shortage of qualified science and mathematics teachers is well known. Our country has never produced the number of teachers required to meed the demand. At this writing, science and mathematics are in a period of significant expansion. New technology has extended scientific applications and altered the perception of these disciplines in the board rooms of our largest and most well known corporations. Unless our nation is able to improve the teaching of science and mathematics the impact of our economy and society at large will be a misfortune of catastrophic proportions. Glen Seaborg, a Nobel prize winner in chemistry, recently characterized this impact and its effects as "unilateral economic disarmament."

Clearly, some effort has been made to implement "mid-course" corrections. Momentum has been building among the states to increase competence in science and mathematics. California and Florida, which led the trend to abandon graduation standards, are now leading in the other direction by proposing the enactment of new levels of excellence for graduation from high school. At both the state and federal levels legislation has been proposed to provide tax credits and cancellable loans to college students studying to teach science and mathematics. Many boards of education are considering imposing the requirement that all secondary students take at least three years of mathematics and science. Consideration is also being given to stopping the practice of staffing mathematics and science classes with individuals who are not certified in these teaching fields.

The National Science Foundation-Department of Education report to President Carter (Science and Engineering Education for the 1980's and Beyond) stresses that the guiding principle for our education system should be a "new educational commitment to excellence in science and technology education for all Americans." To achieve this objective, our present system must undergo fundamental changes. School budgets must be increased in order to provide additional funding for laboratories, new textbooks, equipment, and micro computers. Teacher salaries, especially for those qualified to teach science and mathematics, must be increased. Continuing education and retraining programs for primary and secondary school teachers need to be strengthened. Qualified individuals from the business and retired sectors must be invited and given permission to teach in our public schools. There are other initiatives that must be pursued with intelligence and vigor.

This document is intended to serve as one starting point for addressing the need to increase our national commitment to excellence in science and mathematics. We hope that the reader will agree that we have made a good beginning.

Robert H. Koff
Dean, School of Education

OVERVIEW

The symposium whose proceedings are included in this document was designed to inform diverse segments of society of the catastrophic decline in the supply of mathematics and science teachers. It was also seen as a first step in a continuing dialogue among educators, legislators and corporate executives in New York State. The symposium was, thus, structured as a "lighthouse" endeavor with the focus on sensitizing the non-education community, in particular high-technology industry, to a situation which will have enormous deleterious effects on their ability to expand, to modernize, to reap the rewards of technological advancement.

The morning session was devoted to a presentation of data and issues. As the proceedings show, that session began with a welcome from Dean Robert Koff, Dean of the School of Education at SUNYA. Dean Koff is former Director of Teacher Education, Stanford University, former Dean of College of Education, Roosevelt University, Chicago and a member of several state and national committees including President Carter's National Advisory Council on the Education of Disadvantaged Children.

A keynote address by Dr. Margaret Farrell, Chair of the Department of Teacher Education, SUNYA, followed. Dr. Farrell, a professor of mathematics education, is past president of the Association of Mathematics Teachers of New York State, a past-member of the National Commission on the Education of Teachers of Mathematics, author and speaker at professional meetings.

The major event of the morning was the presentation of "Data on the Extent of the Shortage" led by Dr. Benjamin Lindeman, Associate, Bureau of Mathematics Education, NYS Education Department with the assistance of Dr. Thomas Boehm, Associate, Bureau of Science Education, NYS Education Department. Dr. Lindeman is immediate past president of the Association of Mathematics Teachers of New York State under whose leadership a state committee on the shortage of mathematics teachers was formed.

Dr. Boehm is the director of several NSF-funded projects in environmental education and a contributor to programs and committees of the Science Teachers Association of New York State.

Following their presentation, Dr. Vincent Gazzetta, Director of the Division of Teacher Education and Certification of the NYS Education Department, spoke on the "Regents' Initiatives," some of which have already been submitted to the state legislature for consideration. Dr. Gazzetta, a former science educator, has been active in all aspects of teacher education and certification and has vigorously provided leadership for many state ventures.

The morning ended with a brief, informal question-answer period which extended through the lunch hour as participants continued to react to what they had heard.

The afternoon session consisted of a period devoted to the interaction of three working groups, followed by a wrap-up session in which group recorders reported on major recommendations.

Caveat: These proceedings will reveal no momentous decisions and no immediate solutions. The symposium was not intended as a decision-making event. Valuable decisions depend, for their value, on the deliberations of a group already knowledgeable in most aspects of a problem. This symposium, like others at the national level, was an attempt to bring that knowledge to a key group of citizens.

* * * * * * * * * *

Symposium Steering Committee

Margaret Farrell, Coordinator

Walter Farmer

James Kiepper

Benjamin Lindeman

Janet McDonald

Fredric Paul

E. Craig Sipe

Invited Participants

1. Nelson Armlin
   Capital Area School Development Association
   State University of New York at Albany

2. Thomas Boehm, Associate
   Bureau of Science Education
   State Education Department

3. David A. Demont
   General Electric
   Silicone Products Division

4. Donna E. DeSeyn, President
   Science Teachers Association of New York State

5. Rosemary Essepian, Research Associate
   Senator Farley's Office

6. Walter Farmer, Science Education
   Department of Teacher Education
   State University of New York at Albany

7. Margaret A. Farrell, Mathematics Education
   Department of Teacher Education
   State University of New York at Albany

8. William G. Floyd
   NYS School Boards Association

9. Vincent Gazzetta, Director
   Division of Teacher Education and Certification

10. Philip Gibbons, Chair
    Mathematics Department
    Bethlehem Central High School

11. Kenneth Goldberg
    Mathematics Education
    New York University

12. Dolores Granito, President
    Association of Mathematics Teachers of New York State

13. James Kiepper
    Department of Teacher Education
    State University of New York at Albany

14. Robert Koff, Dean
    School of Education
    State University of New York at Albany

15. Dennis R. Lauro, Jr.
    Education Services
    New York State United Teachers

16. Ben Lindeman, Associate
    Bureau of Mathematics Education
    State Education Department

17. George Martin
    Mathematics Department
    State University of New York at Albany

18. Martha McAvin
    SUNY Central Administration
    State University Plaza

19. Janet McDonald, Mathematics Education
    Department of Teacher Education
    State University of New York at Albany

20. Fredric Paul
    Bureau of Mathematics Education
    State Education Department

21. Richard Pfister
    Director of Finance of
    Senate Education Committee

22. Anthony Ricciardelli, CPA
    Edwards, Williams, McManus, Ricciardelli and Coffey

23. Jeffrey Saelens, Director
    Department of Pharmacology
    Sterling-Winthrop

24. H. Craig Sipe, Science Education
    Department of Teacher Education
    State University of New York at Albany

25. Robert Somers
    Facilities Engineering
    Watervliet Arsenal

26. Thor N. Trolsen
    Manager, ISMT Recruiting
    General Electric Company

27. Robert VanSlyke, Manager
    Community Relations-Employee Relations
    Atlantic Cement Company, Inc.

Keynote Address: MYTHS ABOUT THE MATHEMATICS/SCIENCE TEACHER SHORTAGE

Margaret A. Farrell, Chair
Department of Teacher Education
State University of New York at Albany
and
Symposium Coordinator

Why have this symposium? Why take hours out of the day of busy people, leaders in their organizations? Of course we all know there's a shortage. Some of us read a February 1982 article in U.S. News and World Report, which cited 22 percent of mathematics teaching positions vacant nationwide. In this area, the local Hearst papers have included several articles on the crisis in the supply - side economics of producing chemistry and physics teachers. It's too bad but it really isn't worth a day of talk, is it?

The unspoken assumptions behind such a question can be summarized in three myths.

Myth #1: The solution is obvious, though not easy. Pay teachers more; then your shortage will disappear.

Myth #2: It's just a matter of retraining. We've learned to do that in industry. When we have too many mechanical engineers, we retool and reeducate.

Myth #3: It's clearly a problem, but not for industry. We need talented, highly trained people and we can and will pay for them.

As we all know, every myth has a kernel of truth which has been misapplied or overgeneralized. Take myth one, for example. There is no doubt that many mathematics and science teachers have left schools for higher paying industrial jobs. Were this 1970, a comparable pay scale in schools would not only mitigate against these departures but help attract young men and women to a teaching career. In 1970, we had a reasonable pool of new teachers. However, in the past

decade, the pool has declined beyond belief. Some examples--Rutgers University will graduate one mathematics teacher in 1982 and one in 1983. At San Jose, California, only seven mathematics teachers have graduated each year for the last 4 years. From all 12 state-supported colleges in Minnesota, a total of one physics teacher was graduated in 1981. In New Hampshire, no mathematics teachers will graduate in 1982 and there will be at least forty vacancies. An increased pay scale instituted now would not measurably reverse the shortage for five to ten years.

The second myth also has the characteristic of the "quick fix." Start a crash program and retrain teachers in fields with less demand, e.g. social studies, elementary teachers. In fact, these two examples are from fields with some oversupply. Unfortunately, those who have potential for retraining, physics, earth science and chemistry teachers, are also in short supply. In a few cases, some elementary teachers, those with a mathematics concentration, might be retrained. Such a program is being instituted at C.W. Post College, Long Island. But most special subject teachers differ so radically in their collegiate and, sometimes, high school specializations, that retraining generally amounts to trying to put square pegs in round holes.

The third myth pervades the thinking of both educators and lay people. It is based on the assumption that talented people will be unaffected by inadequate and inappropriate instruction in the foundation courses of mathematics and science. According to the April, 1982 issue of Education Daily, the decline in the quality of mathematics and science education is at "a near-crisis level." As a result the National Science Foundation has appointed an 18-member Commission on Pre-College Education in Mathematics, Science and Technology to find ways to

meet the country's critical need for high school graduates with solid backgrounds in mathematics and science. Former U.S. Commissioner of Education, Ernest Boyer, sounded the same clarion call for action when he unfavorably compared our present pool of technological expertise to the pre-Sputnik days. Further, the evidence does not support the thesis that talent will rise to the top despite education. The pool of academically capable students is drying up at a most critical time for American industry.

Will industry be forced to do remedial work in mathematics and science? How successful will they be in undoing 12 to 16 years of uncertain and uninformed instruction?

This is the WHY of this symposium - - to alert leaders who have a stake in the problem; to consider suggestions made by the Board of Regents; to assess those suggestions and to initiate others. Industry is an economic force; it can be a political, social and moral force for action in this crisis.

PRESENTATION OF DATA ON THE EXTENT OF THE SHORTAGE

Benjamin Lindeman, Associate
Bureau of Mathematics Education
State Education Department

and

Thomas Koehm, Associate
Bureau of Science Education
State Education Department

For the past decade now the popular press has been announcing that teaching is a poor career choice for young people. Declining birth rates and school enrollments have caused school planners to make major modifications in projections for needed teachers. Even as recently as 1978, the Occupational Outlook Handbook advised that the job situation for teachers was discouraging. Popular literature from sources such as Senior Scholastic and Readers Digest echo that a surplus of teachers makes teaching a very poor career choice.

However, at the same time (1978), the Bulletin for Leaders from the NCTM reported that a national random survey of 200 math supervisors indicated that at the end of the 1977-78 year, nearly 10% of the mathematics teaching positions in the nation were vacant. How was this possible with the surplus mentioned before? The answer lies in looking at subject matter teachers in particular, rather than teachers in general. Data from the state of Missouri, where a critical shortage of mathematics teachers exists, illustrates this point. A supply and demand survey showed the following.

TABLE 1

1973-1978 Teacher Supply and Demand Averages for Missouri

Teaching Major	Positions Available	Teachers Trained	
English	286	378	32% Surplus
Mathematics	246	217	12% Shortage
Physical Education	207	613	196% Surplus
Science	287	241	16% Shortage
Social Studies	219	509	132% Surplus
Totals	1245	1958	57% Surplus

Instead of a general surplus of secondary teachers, these detailed data actually show a shortage of mathematics and science teachers.

In a 1982 survey, the Association for School, College and University Staffing surveyed Teacher Placement offices to ascertain the relative demand in all teaching areas. Four teaching fields were identified as having considerable shortage. Mathematics and physics were included among these. Fourteen fields were identified as having a slight teacher shortage. Earth science, biology, and chemistry were included among these. All 9 geographic areas of the United States indicated a shortage in mathematics and physics. The region containing New York State seemed to have an extremely critical shortage (4.86 on a 1-5 scale).

For many schools, enrollment peaked during the early seventies. However, increased demand for mathematics and science courses by secondary school students as well as an increase in student enrollment in computer related courses is expected to significantly counteract the declining enrollment. It is entirely feasible that the total number of students enrolled in secondary school mathematics and science may not decline at all, despite the general population decline. State mandates requiring school districts to provide remediation also

make additional demands on mathematics staff.

The Iowa State Department of Public Instruction made a study of secondary mathematics teachers by states in 1980. The following table shows the responses received from these states.

Table 2

Estimated Supply of Secondary Mathematics Teachers by State - 1980

Supply Status	Number	Percent
Critical Shortage	16	32%
Shortage	12	24%
Adequate	10	20%
Slight Surplus	1	2%
Surplus	5	10%
No Response	6	12%

The following national statistics were released during 1982 National Education Week.

1. The average number of secondary mathematics teachers prepared by schools of education has declined by 77% in the last ten years and one-half of those prepared went into industry.

2. In the Pacific coast states, 84% of new teachers hired to teach mathematics and science are thought to be unqualified. Nacionwide, 50% are considered unqualified.

Sixty-one percent of the mathematics supervisors responding to a 1980 NCTM sponsored survey indicated that finding a certified teacher of mathematics was difficult. Seventy-two percent of the supervisors predicted that the situation would worsen over the next two years. This same survey found that in some large cities there was a ratio as low as one applicant for each 10 mathematics

teaching vacancies. In addition, the NCTM survey found almost 25 percent of the reported teaching positions in mathematics for the 1980-81 school year were filled by teachers not permanently certified in mathematics.

A recent report by the National Science Foundation (NSF) and the US Department of Education has stated that, with the possible exception of computer sciences and engineering, the United States will have an adequate supply of scientists and technologists, but will not have the teaching staff to maintain that supply.

Recent NSF figures indicate that, nationwide, 16% of all elementary school teachers were not sufficiently prepared to provide basic training in science and mathematics to their students.

The following statistics on number of certified teachers, number of emergency certificates and supply/demand data are just samples from a bleak collection of information on mathematics teaching.

1. Between 1978 and 1979, the number of emergency certificates issued in Missouri to mathematics teachers increased 43%.
2. In 1979-1980, North Carolina reported that 45% of its mathematics teachers were not certified to teach mathematics.
3. In 1980, Virginia reported a 38% gap between jobs available and prepared mathematics teaching graduates.
4. In 1981 a study by the National Education Association reported a 22% gap between supply and demand for mathematics teachers nationwide.
5. In that same year, 1981, a study done by the National Council of Teachers of Mathematics reported that 26% of the mathematics teaching positions were filled by teachers with either no, or temporary, certification in mathematics.

The problem is not much different in New York State. Earlier this year the New York State Division of Teacher Certification surveyed the school districts of New York State, asking them to indicate problems of quantity or quality in their teacher recruitment efforts. Only 43 districts indicated that they had no problem in the area of mathematics. On the other hand, 146 districts indicated they had a problem with quantity and 130 districts indicated a problem with quality of the candidates.

One of the major reasons why school districts are having difficulty finding qualified candidates is the decline in the number of new teachers. Let us look at the number of students who have completed certification through an approved college program in teacher education. Tables 3 and 4 provide data on the period from 1975-1979 and the projections for 1980-1985.

Table 3

Number of Provisional Certificates Through NYS Approved Programs

Field	1975	1976	1977	1978	1979	Percent of Decrease 1975-79
Mathematics	715	553	379	286	221	69%
Biology*	313	304	258	198	179	43%
Chemistry*	133	110	68	79	61	54%
Physics*	48	21	11	14	24	50%
Earth Science*	76	65	49	46	39	49%

*These numbers include those who obtained a combined general science certificate.

Table 4

Projected Number of Provisional Certificates Through NYS Approved Programs

Field	1980	1981	1982	1983	1984	1985
Mathematics	166	124	93	70	52	39
Biology	156	136	118	103	90	78
Chemistry	51	43	36	30	25	21
Physics	20	16	13	11	9	7
Earth Science	34	30	26	23	20	18

When these data are combined in a graphic fashion, they provide a disturbing picture of the supply/demand situation in New York State. Figures 1-3 depict trends for each of the disciplines in mathematics and science.

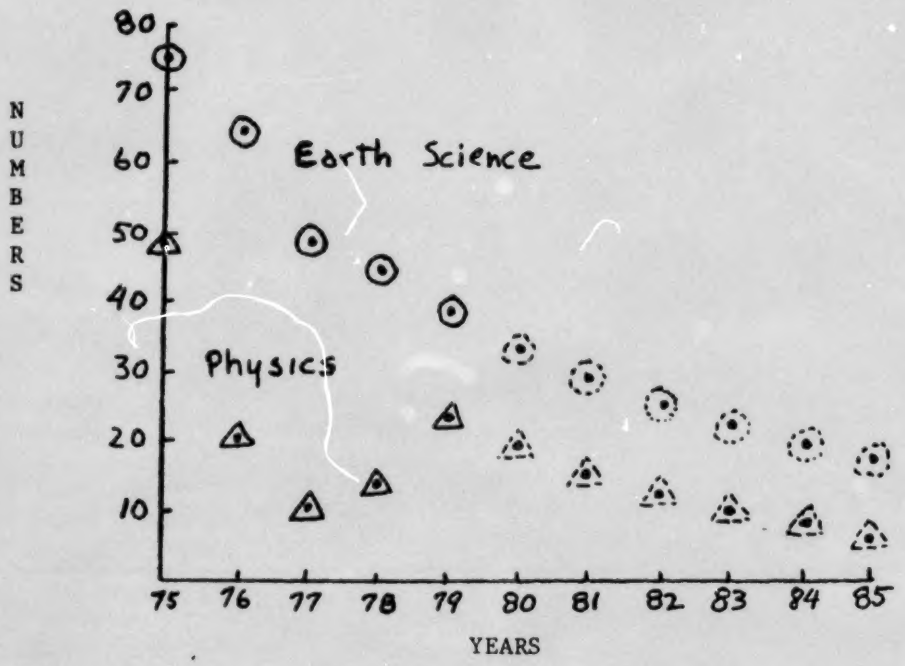

Figure 1. Provisional certificates through approved programs in earth science and physics. (Data indicated by ⊙ and ⊙ are extrapolated.)

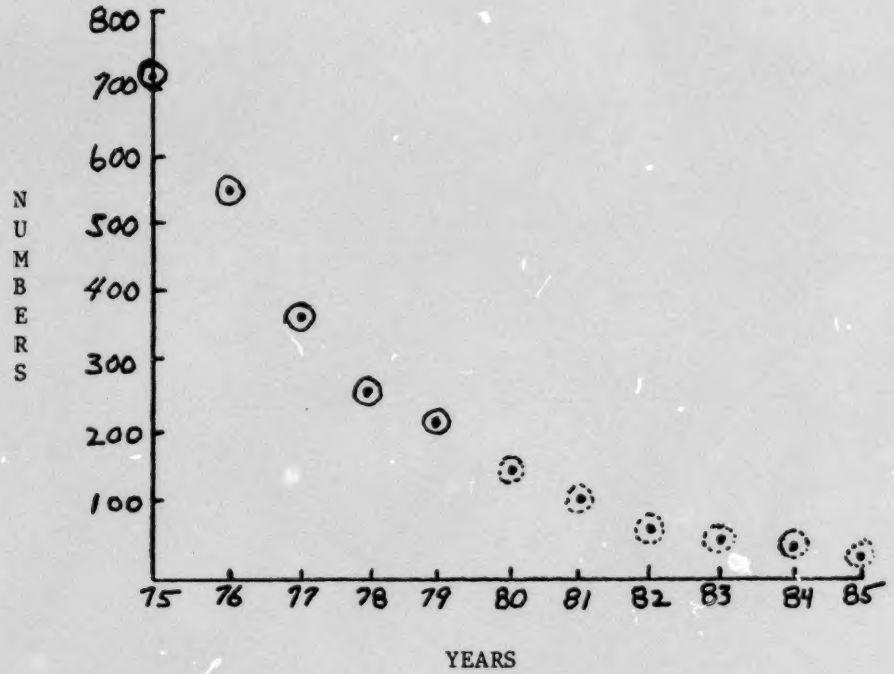

Figure 2. Provisional certificates through approved programs in mathematics. (Data indicated by ⊙ are extrapolated.)

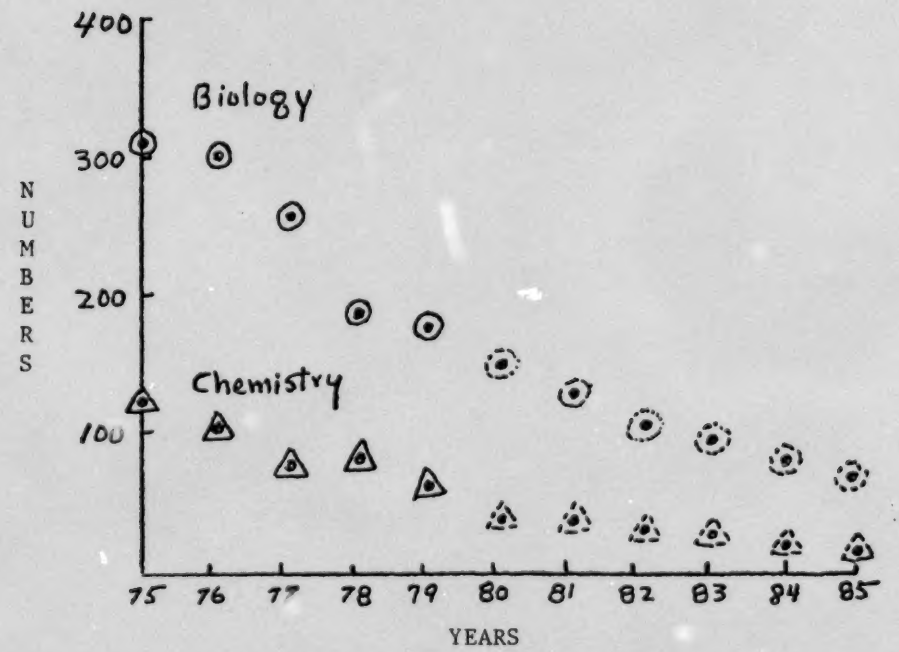

Figure 3. Provisional certificates through approved programs in biology and chemistry. (Data indicated by ⊙ and △ are extrapolated.)

The reasons for the present shortage are many. As already mentioned the false belief that a surplus existed is one reason. Other reasons might be:

a. Competition by industry to attract persons with mathematics and science training. Not only does industry have a similar demand for the mathematically talented, but they most often are able to offer more attractive compensation. The tremendous growth of the computer industry continues to be a major factor in providing jobs in the industrial marketplace for both new and experienced teachers.

b. Greater opportunities for women in the business, government and industrial world. Women who might have in the past considered a career in teaching are now turning to the world of business for alternative opportunities. This trend is certain to continue as more women become aware of the many occupational choices open to them.

c. The attitude held by many concerning the job of teaching. Violence in the classroom, national concern with classroom discipline, teacher burnout, classroom stress, lack of community support, lack of student respect and confrontation with school administrators and Boards of Education are phrases commonly heard today. These problems help to discourage young people from entering the profession and add to the desire of the veteran teacher to leave the classroom. To many, the rewards of teaching don't seem to be what they used to be and they are becoming aware of more attractive options.

What can we do about this situation? That is our charge here today -- to look into possible solutions. The next participant in the program, Dr. Vince Gazzetta of the Division of Teacher Education of the State Education Department will discuss with you some of the initiatives that the Board of Regents is considering.

REGENTS INITIATIVES

Vincent Gazzetta, Director
Division of Teacher Education
and Certification
State Education Department

I am going to touch on four points today and to benefit both you and me I will announce the fact that I am moving to the next point. This helps you know when I'm getting close to ending and it relieves me of devising those tough bridging sentences between sections.

Point I. There is a vanishing species called public school teacher. I say that because the total number of certificates issued over the years has been dramatically reduced. In 1971 we issued 34,741 provisional certificates. In 1979, 15,199 provisional certificates were issued - a reduction of 56%. That's not mathematics and science people. That's all areas of certification.

If we look at the specific certification areas we see problems in the following areas: physics, business, agriculture, vocational trade and technical areas, teaching the blind, and teaching the deaf, foreign languages, mathematics, chemistry, earth science, home economics, industrial arts, teaching the speech and hearing handicapped and teaching pupils with other handicaps. The problem is becoming widespread and attention needs to be called to the situation.

Now, the world of mathematics and science. You have already had before you a fine display of discouraging data. I'd like to add to the data base.

One of the Department's responsibilities is to approve all collegiate programs which lead to a degree, certificate or license. Included in that procedure is the approval of those programs, proposed by institutions of higher education in the State, which lead to certification as a teacher of

mathematics or a teacher of one or more of the sciences.

We have on the books:

77 programs to prepare teachers of mathematics

80 programs to prepare teachers of biology

59 programs to prepare teachers of chemistry

41 programs to prepare teachers of physics

26 programs to prepare teachers of earth science

That looks like a pretty decent array of programs that should be capable of producing a sufficient number of persons to meet the mathematics and science needs of the elementary and secondary schools. However, the number of people electing to enroll in those programs - our supply side economics - is diminishing at an ever increasing rate.

To document that statement, the following is offered:

Area	No. of Programs	Non Producing Programs 1975	1979
Mathematics	77	5	23
Biology	80	15	26
Chemistry	59	21	33
Physics	41	17	26
Earth Science	26	8	12

Point 2. The problem of a diminishing supply has not gone unnoticed. In November of 1980 the Commissioner and Regents convened a major invitational conference on the recruitment and career expectation of teachers. One of the clear concerns that was expressed at the conference was the growing supply problem in the mathematics and science areas. Conference participants represented a cross section of the informed public and all sectors mentioned the situation. As a direct outcome of the conference, the Department submitted

four legislative/budgetary proposals to the 1982 legislature.

Before I describe the proposals, it is important to note that we clearly realize that the proposals represent what might be called "a drop in the bucket" in comparison to the need.

The Department proposed the following actions:

1. The establishment of 24 undergraduate scholarships per year for talented prospective teachers of elementary and secondary mathematics and science. Two scholarships from each of the judicial districts - one in mathematics and one in science - would be awarded on a competitive basis. The scholarships would provide up to $2,500 per year for up to four years and recipients would be required to teach the subject in the public schools for the time equal to that during which they received such scholarships.
2. The establishment of 100 part-time graduate tuition reimbursement fellowships. The fellowships would be awarded on a competitive basis and provide up to $2,000 a year for a period of two years. Preference would be given, for up to 30 of the fellowships, to qualified teachers whose positions have been abolished. The recipients would be required to teach in the public schools.
3. The establishment of 24 Regents consultantships in mathematics and science. One in each area in each of the 12 judicial districts. The consultants would be chosen on the basis of qualifications and exceptional merit in teaching mathematics and science at the elementary and secondary level. Each consultant would be an employed teacher who would be given a year's leave of absence. The consultants would work with school district staffs in the judicial district to improve the teaching of mathematics and science by

advising on curriculum matters, conducting inservice workshops and teaching demonstration lessons.

4. The establishment of a major statewide inservice education program to increase the mathematical and scientific knowledge of teachers presently employed in the elementary and secondary schools. The proposed activities would include collegiate and local workshops given by trained traveling master teachers, the training of local leaders and a mathematics science workshop for supervisors and administrators.

The State support requested for the total program was $1,980,000. As of this date I know of no action (pro or con) being taken by the legislature.

Point 3. I had the opportunity last week of participating in a National Convocation on Pre-college Education in Mathematics and Science. The convocation was sponsored by the National Research Council of the National Academies of Science and Engineering. The Convocation was attended by some 500 people and we heard from a number of illustrious people from mathematics, the sciences and business and industry.

The great majority of the speakers addressed the problems and a handful proposed some solutions. The proposed solutions were:

1. get more women and minorities involved
2. contract school management to private business and industry
3. develop the public's interest in science and mathematics
4. expand the definition of mathematics to include problem solving
5. develop magnet schools specializing in mathematics and science
6. establish high schools which focus on mathematics and science similar to the Bronx High School of Science

7. form partnerships with business and industry
8. set higher standards for higher school graduation
9. establish higher requirements for entrance into college
10. do away with the single salary schedule
11. increase the number of hours in the school day, number of days in the school year and offer more summer programs
12. increase inservice offerings and
13. have a mathematics and science specialist in every elementary school.

I must admit I was somewhat disappointed that specifics of the solutions were not more fully explicated and that some of the solutions were, I thought, a degree or two away from the real world of public school education. I was, however, struck with the interest and commitment of speakers from business and industry including: Control Data Corporation, DuPont and McGraw Hill. There seemed to be a willingness on the part of business and industry to develop cooperative endeavors with the schools to seek solutions to the problem.

Point 4. Two of the suggestions made at the national meeting dealt with increasing the salaries of teachers of mathematics and science so that public school service would be more competitive with business and industry.

The real world suggests three things. First, such a plan could possibly cause a major uprising among the 192,000 persons presently serving in the schools. That potential would result in more problems in New York State than any solution might be worth. Second, I have serious doubts whether the State and/or the local districts could raise the ante to a competitive level. This would especially be true in the large cities where the problems are most serious. Third, I believe that salary is one of the major reasons why persons in mathematics and science are seeking positions with employers other

than school districts. On the basis of those three reasons I would propose an idea as a stimulus for discussion.

I believe the significant reduction in the number of persons preparing to be teachers of mathematics and science in the elementary and secondary schools is creating a critical situation that, over time, will have a negative impact on the society at large. Capable persons who would otherwise enroll in programs preparing them for teaching are enticed by the salary and prestige being offered through other employment opportunities.

It is proposed that, as an investment in the mathematical and scientific competence of future generations, consideration be given to a joint business/industry/education effort to enable capable high school students to enroll in collegiate programs preparing them for teaching in the elementary and secondary schools for three years and then to enter positions in business and industry.

The joint effort would consist of the following:

1. a joint initiative which would encourage capable high school students interested in mathematics and science to enroll in programs to provide preparation in the discipline and in teaching,
2. an agreement that graduates of such programs would be recruited by both a school district and a business or industry with the following stipulations:
   a) the graduate would agree to teach for three years
   b) the business or industry would employ the graduate during the summer

c) the business or industry would provide an additional stipend to enable the graduate to commence graduate study leading to a master's degree in the discipline

d) at the end of the three year teaching period, the teacher could resign from his/her teaching position and join the sponsoring business/industry.

I leave you with that proposal which I would hope will stimulate your creative imagination and challenge New Yorkers to find a series of feasible solutions to a complex problem.

THE WORKING GROUPS

Three working groups -- each one structured to include representatives from industry, the legislature, mathematics and science education and specific educational interest groups -- considered a set of specified questions under an appointed group leader. A designated reporter/recorder summarized each group's suggestions and reactions in a final, wrap-up session.

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Group #	Group Leaders	Group Reporters/Recorders
1.	Donna DeSeyn	Walter Farmer
2.	Dolores Granito	Fred Paul
3.	Nelson Armlin	Janet McDonald

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Suggested Questions/Issues

1. What can industry do to both reverse the decline in the number of mathematics/science teachers and to fill the gap in those classrooms in

the meantime?

a. Industry financed scholarships/fellowships for potentially talented mathematics/science teachers?

b. Establishment of a stated number of cooperative teaching/industry positions open competitively to qualified mathematics/science teachers? (Teach two semesters; industry work one semester. College faculty in the sciences actually often do this.)

c. Midcareer internships provided by business for teachers with 12 - 15 years teaching experience?

d. Industry/school cooperative counseling programs in high schools where industry might support a career choice of mathematics/science teaching?

2. What kinds of legislation might be helpful? At any level?

a. Tax-credits for teachers?

b. Incentive pay for these premium positions? Pros/cons?

c. Restrictions on the number of emergency certificates which may be issued in a particular field? (Such restrictions would help to highlight the issue, rather than mask it.)

SUMMARY OF WORKING GROUPS' CONCLUSIONS AND RECOMMENDATIONS

The three groups considered several aspects of the problem and possible directions to solve it. Most participants in all groups had been unaware of the extent of the shortage. Participants were also concerned about the long-range negative impact of continued shortages on industry and society in general.

It should be noted that none of the working groups viewed any single recommendation as the simple solution to a complicated problem. Also it became obvious that each recommendation brought with it negative as well as

positive aspects which would need to be addressed prior to implementation. Recommendations focused on the following major points:

1. industry financed scholarships or fellowships
2. loans with forgiveness clauses for students who enter and remain in teaching for x number of years
3. summer job guarantees in industry
4. summer job guarantees in industry as part of a 3 year program after which options for full-time employment in industry would be possible
5. cooperative teaching/industry positions
6. mid-career internships for teachers with 12 - 15 years experience
7. emphasis of the positive aspects of teaching as a career by current mathematics/science teachers
8. one-shot bonuses to enter science/mathematics teaching
9. differential salary schedules for mathematics/science teachers with possibilities of extending the practice to other fields where shortages may develop
10. tuition free education for those enrolled in mathematics/science programs
11. plans to maximize the negative aspects of teaching such as discipline problems, burn-out, lack of administration support, lack of appreciation and recognition
12. advancement and awards systems based on quality teaching rather than strictly years of service (Might include "endowed chair" concept. Should include monetary as well as other vehicles of recognition.)
13. government sponsored summer institutes to:
    a) upgrade existing pool of teachers
    b) retrain teachers in other related subject matter areas to convert to mathematics/science certification

c) satisfy masters degree requirements without additional financial burden on the teacher

14. tax-credits for teachers

15. evening courses and programs for people in industry who might wish to move into teaching (Most industries will pay for course work.)

16. continued publicity on the current shortage to alert government, industry and the general public to the problem and its consequences

17. campaign to encourage parents to demand fully certified classroom teachers

18. decrease of non-teaching duties

19. watchdog role for professional associations who should lobby against the issuing of emergency certificates to unqualified individuals

20. cooperative, continuing education of guidance counselors. Provide them with current supply and demand data. Urge them to alert able students to consider careers in these fields.

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APPENDIX

MAPS OF TEACHER SHORTAGE

TEACHER SHORTAGES

GENERAL SCIENCE

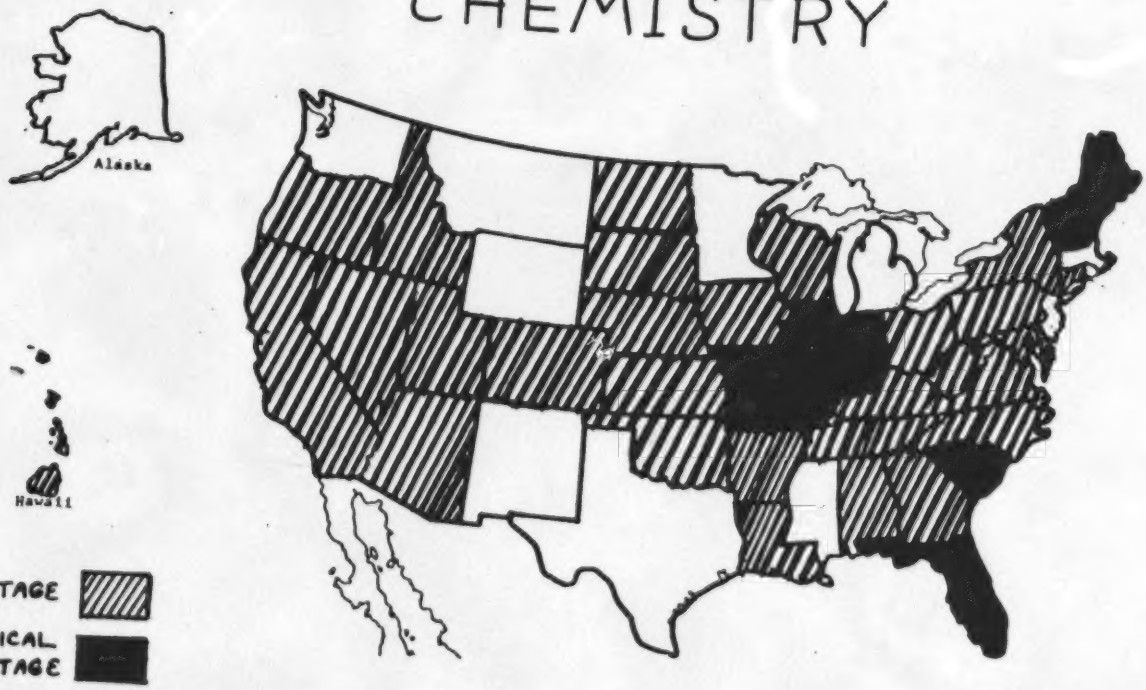
EARTH SCIENCE

DATA SOURCE: NATIONAL STUDY OF THE ESTIMATED SUPPLY AND DEMAND OF SECONDARY SCIENCE AND MATHEMATICS TEACHERS, IOWA STATE UNIVERSITY, 1981

TEACHER SHORTAGES

BIOLOGY

CHEMISTRY

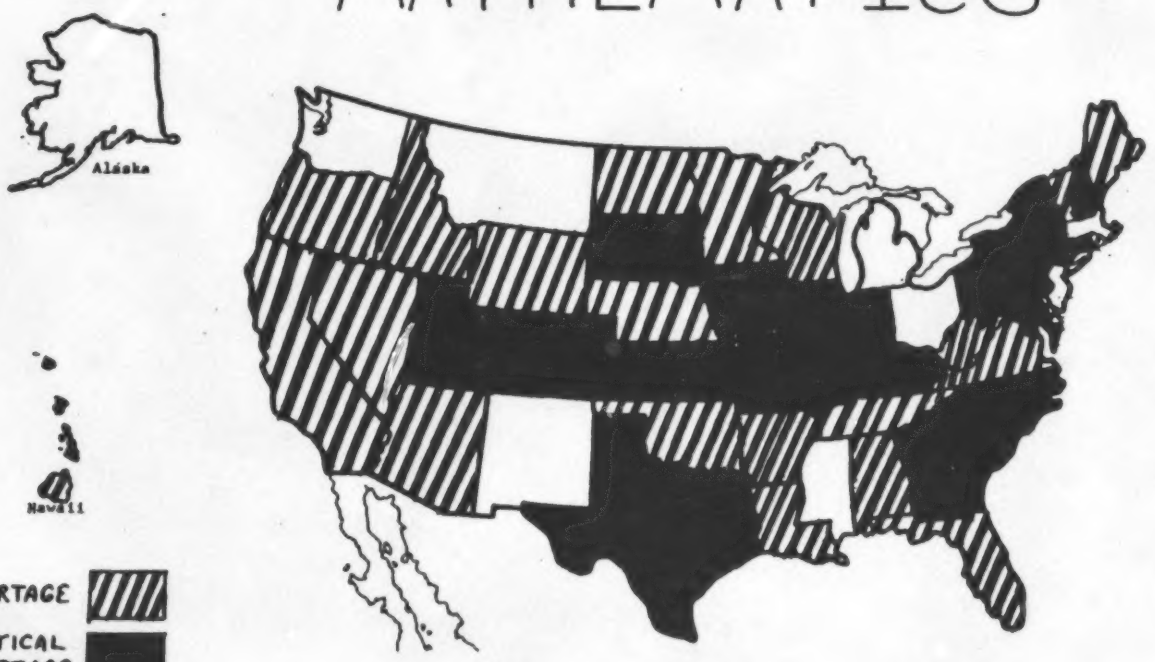


DATA SOURCE: NATIONAL STUDY OF THE ESTIMATED SUPPLY AND DEMAND OF SECONDARY SCIENCE AND MATHEMATICS TEACHERS, IOWA STATE UNIVERSITY, 1981

TEACHER SHORTAGES

PHYSICS

MATHEMATICS



DATA SOURCE: NATIONAL STUDY OF THE ESTIMATED SUPPLY AND DEMAND OF SECONDARY SCIENCE AND MATHEMATICS TEACHERS, IOWA STATE UNIVERSITY, 1981